Fo8∤01 ① R.W

PATENT SPECIFICATION

(11) 1 603 886

1 603 886

(21) Application No. 20221/78 (22) Filed 17 May 1978
(31) Convention Application No. 2809712
(32) Filed 7 March 1978 in
(33) Federal Republic of Germany (DE)
(44) Complete Specification published 2 Dec. 1981
(51) INT CL³ H02J 7/14 7/24
(52) Index at acceptance
H2H 25G BCB BCJ

(19)

(72) Inventors ULRICH MUNZ
EDGAR KUHN and
WILLI GANSERT

(54) A BATTERY CHARGING SYSTEM ESPECIALLY FOR MOTOR VEHICLES

(71) We, ROBERT BOSCH GmbH, a German company of 50, Postfach, Stuttgart, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to a battery charging system preferably for a motor vehicle. Such a battery charging system is already known from German OS 2 354 796 in which the charging monitoring device only indicates a defect when a short-circuit occurs in the voltage regulator. Beyond this, the pilot light only lights up when the a.c. generator is operating below a predetermined speed (starting procedure).

The present invention provides a battery charging system comprising an a.c. generator for charging an electric battery and including an energising winding and a rectifier system, a semiconductor voltage regulator for maintaining the generator voltage constant, which regulator has a power semiconductor switch connected in series with the energising winding and comprising a charging monitoring device, characterised in that, two threshold value stages are provided for sensing a predetermined value below and above the desired regulating value, that the output signals from the threshold value stages as well as a signal for sensing the switching condition of the power semiconductor switch can be transmitted to a logic gating circuit which, not only on the response of the threshold value stage to the sensing of a predetermined value exceeding the desired regulating value and with the simultaneous presence of a current conducting condition of the power semiconductor switch, but also on response of the threshold value stage to the sensing of a predetermined value below the desired regulating value with a simultaneous presence of a current blocking condition of the power semiconductor switch, provides an output signal through which the charging monitoring device can be switched in. The system in accordance with a preferred embodiment of the invention has the advantage that most of the imaginable failures of the entire battery charging system are indicated by the charging monitoring device. In particular, there are defects which can occur with a regulator which is intact. By reason of the increased field of application, the charging monitoring device provides an essentially greater reliability in the monitoring of the battery charging system. Due to the logic gating by the switching condition of the power semiconductor switch in the voltage regulator, the response thresholds of the charging monitoring device can be arranged nearer the desired regulating value without error signals being generated during a temporary deviation in voltage with an intact regulator.

A voltage divider is preferably used directly in the semiconductor voltage regulator for adjusting the regulator desired value to the intended thresholds of the two threshold value stages. Moreover, the voltage divider preferably consists of a plurality of similar series resistors and the tapping for the desired regulating value preferably lies symmetrically between the tappings for the two threshold value stages. Thus, with a suitable selection of the switching threshold only a single balancing for the desired regulating value is necessary and no further balancing for the threshold values.

Furthermore, it is of special advantage to provide the safety circuit consisting of the logic gating circuits and threshold value stages as well as the semiconductor voltage regulator as a single integrated circuit (IC), since in that case a common temperature

and a common temperature cycle are provided. Thus, the switching thresholds of the safety circuit can be made to follow the regulation curve still more closely.

Furthermore, it is of advantage to connect the series circuit of the charging monitoring device and a semiconductor switch for controlling the said charging monitoring device, in parallel with the electric battery and to conduct the pre-excitation current for the excitation winding through a resistor preferably formed as a cold conducting resistor. With the ignition switch closed and the a.c. generator stationary, a battery chrage through the excitation field is prevented by the cold conductor. Beyond this, an increased excitation current is available to the excitation winding during starting up.

An embodiment of the invention is illustrated in the drawings by way of example and is described in more detail in the following specification. Figure 1 shows a circuit arrangement of the embodiment and Figure 2 is a voltage diagram for explaining the method of operation of the embodiment illustrated in Figure 1.

A three-phase generator system 10 comprises, in known manner, the active portion 11 of the generator comprising three-phase windings, not illustrated in detail, which can be energised with the aid of an excitation winding 12. A three-phase bridge rectifier 13 comprising positive diodes 13a and negative diodes 13b is connected to the active portion 11, wherein the anodes of the negative diodes 13b are connected to earth and the cathodes of the positive diodes 13a are connected to a positive line 14. A battery 15 is connected between the positive line 14 and earth. Loads 17 are connected to the battery 15 through a load switch 16 which is provided to symbolise a plurality of switches. Furthermore, the generator system 10 includes additional diodes 19 the cathodes of which are connected to a terminal 20 (terminal D+) and the anodes of which are connected to the active portion 11 of the generator. A known voltage regulator 21 is connected to the generator 10 through the terminal 20 and through a further terminal 22 (terminal DF) wherein the energising winding 12 is connected between the terminals 20 and 22.

First of all, the voltage regulator 21 includes a voltage divider 23 connected between the terminal 20 and earth for setting the desired value for the generator system 11. A stabilising Z diode 24 is connected between a first tapping 25 and earth. A desired value is transmitted to the control unit 27 of the voltage regulator 21 through a further tapping 26 at the voltage divider 23. The actual value is supplied to the control unit 27 through the terminal 20. Such a control unit 27 can be designed in a variety of ways and is known for example from the state of the art set forth in the introduction or from the German OS 2 610 137. The output from the control unit 27 is connected to the base of a power transistor 28 preferably designed as a Darlington transistor, the emitter of which is connected to earth and the collector of which is both connected to the terminal 22 and to the terminal 20 through a free wheel diode 29.

A protective circuit 30 comprises two threshold value stages 31, 32 formed as comparators one input to each of which is connected to the terminal 20. Two further tappings 33, 34 symmetrical with respect to the tapping 26 in the voltage divider 23 are connected respectively to the second inputs to the comparators 31, 32. The outputs from the comparators 31, 32 are each connected through a respective time delay member 35, 36 to a respective pulse shaping stage 37, 38 formed preferably as a Schmitt trigger. The output from the pulse shaping stage 37 is connected through an AND gate 39 to one input to an OR gate 40 the output from which is connected to the base of a transistor 41. The output from the pulse shaping stage 38 is connected through an inverter 42 to one input to an AND gate 43 the output from which is connected to a further input to the OR gate 40. In the first place, the terminal 22 is connected directly to a second input to the AND gate 43 and furthermore is connected through an inverter 44 to a further input to the AND gate 39.

A third threshold value stage which consists of a series circuit comprising Z diode 45 and a resistor 46, is connected between the terminal 20 and earth, wherein the interconnecting point between the Z diode 45 and the resistor 46 is connected to the base of a transistor 47 the emitter of which is connected to earth and the collector of which is connected through a resistor 48 to the terminal 20. The collector of the transistor 47 is connected to a further input to the OR gate 40.

A fourth threshold value stage connected between the terminal 20 and earth is made identical to the third threshold stage 45 to 48 and consists of the components 49 to 52. Moreover, the collector of the transistor 51 is connected to a further input to the AND gate 39.

A switch contact of an ignition switch 53 is connected to the positive line 14, the other contact of which is first of all connected through a cold conducting resistor 54 to the terminal 20 and moreover through a light emitting diode 55 and a resistor 56 connected in series therewith to the collector of the transistor 41 the emitter

of which is connected to earth. Other indicating devices such as, for example, an incandescent lamp or a summing device can of course be used instead of the light emitting diode 55.

The voltage diagram illustrated in Figure 2 will be referred to in the following for explaining the embodiment illustrated in Figure 1. The operation of the a.c. generator 10 in association with the voltage regulator 21 and the electric battery 15 is described in the state of the art set forth in the introduction. The principle involved is that with a deviation in the voltage at the terminal 20 away from the desired value predetermined by the voltage divider 23, the power transistor 28 blocks the energising current through the energising winding 12 when the voltage is too high and conducts when the voltage is too low.

The operation of the protective circuit 30 will be explained in the following with the aid of the various conditions and defects in the system which can occur:

A) The ignition switch 53 is switched in, the generator is stationary, the voltage regulator 21 is ready to operate (starting up). The voltage at the terminal 20 is below the minimum regulating voltage U_{min}, whereby the threshold at the third threshold value stage 45 to 48 is not achieved and the transistor 47 remains blocked. The 1-signal thereby present at the collector of the transistor 47 changes the transistor 41 into its current conducting condition through the OR gate 40, whereupon the light emitting diode 55 lights up. Only when the voltage at the terminal 20 exceeds the voltage U_{min} does the transistor 47 become current conductive and the light emitting diode 55 become extinguished.

B) The voltage at the terminal 20, which normally amounts to U20, drops below the value $U20—\Delta U_2$. Thereby, the switching threshold $U20—\Delta U_2$ of the comparator 32, or a lower threshold, is reached and the output changes from a 1-signal to a 0-signal. This switching edge is delayed in the delaying member 36 with respect to time and is converted into an accurate edge in the Schmitt trigger 28. Thereupon, through the inverter 42, this 0-signal is applied as a 1-signal to one input to the AND gate 43. If, at this instant, the transistor 28 is in its current blocking condition, then a defect occurs since with a voltage which is too low the transistor 28 must become conductive. The 1-signal applied to the terminal 22 is applied to the second input to the AND gate 43 through the output signal from which the light emitting diode 55 is switched in through the OR gate 40 and the transistor 41. On the other hand, if, on exceeding the threshold $U20—\Delta U_2$, the transistor 28 becomes current conductive then the voltage regulator 21 operates currently, the AND gate 43 remains blocked and no error is indicated. Of course, only when the threshold falls below U_{min} is the light emitting diode switched in through the third threshold value stage 45 to 48 despite the current conducting transistor 28. The delaying member 36 has a delay time which is somewhat longer than the switching time of the voltage regulator 21. It must prevent the light emitting diode 55 from lighting up shortly before the voltage regulator 21 has reset. With a switching time for the voltage regulator 21 of substantially 90 μ seconds, the delay time of the delaying member 36 can be set to substantially 100 μ seconds.

C) The voltage at the terminal 20 reaches or exceeds the switching threshold $U20+\Delta U_1$ of the comparator 31. The output from the said comparator 31 thus changes from a 0-signal to a 1-signal which is once more applied in a delayed fashion to an input to the AND gate 39. If the transistor 28 become simultaneously current conductive, then a defective operation occurs once again since with an increased generator voltage this transistor 28 must become blocked. A 0-signal applied to the terminal 22 thereby, is converted by the inverter 44 into a 1-signal. The 1-signal thereby existing at the output from the AND gate 39, once again switches on the light emitting diode 55 through the OR gate 40 and the transistor 41. With a correct reaction from the voltage regulator 21, thus with the transistor 28 blocked, the light emitting diode 55 remains switched off. The function of the time delay member 35 is again the same as described under paragraph B. Below the voltage U_{max}, the threshold value stage 49 to 52 does not respond, the transistor 51 remains blocked and a 1-signal is permanently applied to the input to the AND gate 39 connected to the transistor 51.

D) High over-voltage due to switching off the load when the electric battery 15 is disconnected. With such a load disconnection, which should not normally occur, since the battery will not be disconnected, very high voltages can occur which would destroy the light emitting diode 55 and the transistor 41. Thus, if the threshold U_{max} of the threshold value stage 49 to 52 is exceeded, then the transistor 51 becomes current conductive and blocks the AND gate 39 so that the transistor 41 remains blocked independently as to whether the voltage regulator 21 is operative or not.

The protective circuit 30 and the voltage regulator 21 are preferably arranged in a single integrated circuit (IC) and are provided with a voltage divider 23 which is also integrated therewith or which is located

on a printed circuit board. In this manner, a similar temperature cycle is produced for the groups of components concerned so that the switching thresholds of the protective circuit 30 can be made very close to the control curve U20. The thresholds are varied thereby in accordance with the temperature in the same sense as the regulation curves.

Moreover, the voltage divider 23 can be produced from similar invididual resistors so that the tappings for the thresholds of the two threshold value stages 31, 32 need be simply selected symmetrically with respect to the tapping for the desired regulating value, in order to provide symmetrical thresholds for the regulating curve. Naturally, the thresholds can also be selected asymmetrically. A separate balance of the thresholds is no longer necessary.

The cold conductor-resistor 54 replaces the indicator light according to the state of the art. It has the advantage that, when starting up, a relatively high energising current can be supplied to the energising winding 12. If, however, the ignition switch 53 remains closed and the generator 10 is not operated then the current decreases and battery charging is prevented by the energising winding 12.

WHAT WE CLAIM IS:—

1. A battery charging system comprising an a.c. generator for charging an electric battery and including an energising winding and a rectifier system, a semiconductor voltage regulator for maintaining the generator voltage constant, which regulator has a power semiconductor switch connected in series with the energising winding and comprising a charging monitoring device, characterised in that, two threshold value stages are provided for sensing a predetermined value below and above the desired regulating value, that the output signals from the threshold value stages as well as a signal for sensing the switching condition of the power semiconductor switch can be transmitted to a logic gating circuit which, not only on the response of the threshold value stage to the sensing of a predetermined value exceeding the desired regulating value and with the simultaneous presence of a current conducting condition of the power semiconductor switch, but also on response of the threshold value stage to the sensing of a predetermined value below the desired regulating value with a simultaneous presence of a current blocking condition of the power semiconductor switch, provides an output signal through which the charging monitoring device can be switched in.

2. A battery charging system according to claim 1 characterised in that the charging monitoring device consists of at least one indicating lamp.

3. A battery charging system according to claim 1 or 2 characterised in that a time delay device is connected beyond the threshold value stages.

4. A battery charging system according to claim 3 characterised in that the delay time of the time delay device is greater than the switching time of the semiconductor voltage regulator.

5. A battery charging system according to any one of the preceding claims characterised in that the semiconductor voltage regulator has a voltage divider for setting the desired regulating value and that tappings from the said voltage divider serve to provide the thresholds for the two threshold value stages.

6. A battery charging system according to claim 5 characterised in that the voltage divider consists of a plurality of similar series resistors and that the tapping for the desired regulating value is arranged symmetrically between the tappings for the two threshold value stages.

7. A battery charging system according to any one of the preceding claims characterised in that a third threshold value stage for sensing a lowest regulating voltage is provided, which lies below the threshold of the threshold value stage for sensing a predetermined value which is below the desired regulating value and that when the said lowest regulating voltage is exceeded an additional signal can be generated for switching in the charging monitoring device.

8. A battery charging system according to claim 7 characterised in that the additional switching in signal and at least one of the output signals from the logic gating circuit control the charging monitoring device through an OR gate.

9. A battery charging system according to any one of the preceding claims characterised in that a fourth threshold value state for sensing a maximum regulating voltage is provided, which lies above the threshold of the threshold value stage for sensing when a predetermined desired regulating value is exceeded and that when the said maximum regulating voltage is exceeded, a signal can be generated for switching off the charging monitoring device.

10. A battery charging system according to any one of the preceding claims characterised in that the charging monitoring device and a semiconductor switch connected in series therewith and to the control input to which are applied the control signals for the charging monitoring device, are connected in parallel with the

electric battery and that a pre-energising current for the energising winding can be supplied through a resistor.

11. A battery charging system according to claim 10 characterised in that the resistor is formed as a cold conducting resistor.

12. A battery charging system according to any one of the preceding claims characterised in that the protective circuit consisting of the logic gating circuits and threshold value circuits as well as the semiconductor voltage regulator are formed as an integrated circuit.

13. A battery charging system according to claim 12 characterised in that resistors are arranged on a printed circuit board.

14. A battery charging system substantially as hereinbefore described with reference to the accompanying drawings.

A. A. THORTON & CO.,
Chartered Patent Agents,
Northumberland House,
303/306 High Holborn,
London, WC1V 7LE.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1981
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1603886 COMPLETE SPECIFICATION

2 SHEETS This drawing is a reproduction of the Original on a reduced scale

Sheet 1

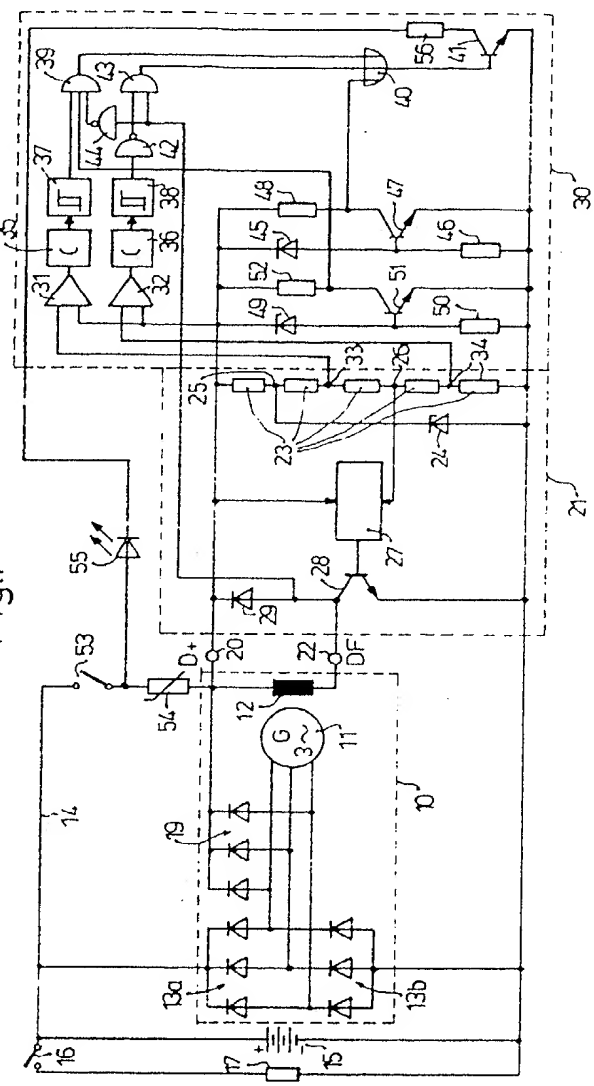

Fig.1

Fig.2